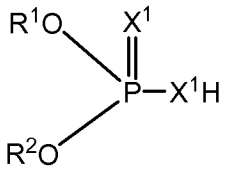
CLAIMS

1. (Currently amended) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising:

(A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent; a metal salt of one or more phosphorus-containing compounds represented by the formula



(I)

wherein in formula (I), X^1 and X^2 are independently O or S, and R^1 and R^2 are independently hydrocarbyl groups, the average total number of carbon atoms per phosphorus-containing moiety being at least 10.4, wherein at least one of the ~~in~~ R^1 and R^2 groups in ~~for the~~ one or more of the phosphorus-containing compounds ~~being at least 10.4, wherein~~ contains 4 or fewer carbon atoms and up to about 40 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms; and an acylated nitrogen containing compound having at least about 10 aliphatic carbon atoms and a TBN of at least about 2; the lubricating oil composition being characterized by a phosphorus concentration of up to about 0.12% by weight and the substantial absence of copper;

(B) adding the lubricating oil composition to the engine;

(C) operating the engine;

(D) generating a lean-phosphorus containing exhaust gas; and

(E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.

2. (Previously presented) The method of claim 1 wherein during step (A) the weight ratio of detergent metal to phosphorus in the lubricating oil composition is from about 0.5:1 to about 10:1.

3. (Previously presented) The method of claim 1 wherein the lubricating oil composition has a viscosity of up to about 16.3 mm^2/s (cSt) at 100°C.

4. (Previously presented) The method of claim 1 wherein the base oil comprises a mineral oil.

5. (Previously presented) The method of claim 1 wherein the base oil comprises a poly-alpha-olefin or an oil derived from Fischer-Tropsch synthesized hydrocarbons or mixtures thereof.

6. (Previously presented) The method of claim 1 wherein in formula (I), X^1 and X^2 are each S, and R^1 and R^2 are independently alkyl or alkenyl groups of about 6 to about 18 carbon atoms.

7. (Previously presented) The method of claim 1 wherein in formula (I), X^1 and X^2 are each S, and R^1 and R^2 are aromatic groups.

8. (Previously presented) The method of claim 1 wherein the metal used in the metal salt of a phosphorus containing compound is zinc.

9. (Previously presented) The method of claim 1 wherein at least about 80% by weight of the phosphorus present in the lubricating oil composition is present in a compound represented by formula (I) wherein R^1 and R^2 are independently hydrocarbyl groups of about 6 to about 18 carbon atoms.

10. (Previously presented) The method of claim 1 wherein the alkali or alkaline earth metal-containing detergent is a salt of an organic sulfur acid, carboxylic acid, lactone, phenol, or hydrocarbyl substituted saligenin.

11. (Previously presented) The method of claim 1 wherein the alkali or alkaline earth metal-containing detergent is a salt of a linear oligomer or polymer containing unsubstituted or substituted phenol units and unsubstituted or substituted salicylic units.

12. (Previously presented) The method of claim 1 wherein the alkali or alkaline earth metal is sodium, lithium or calcium.

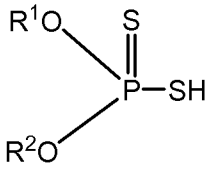
13. (Previously presented) The method of claim 1 wherein the acylated nitrogen-containing compound is derived from a carboxylic acylating agent and at least one amino compound containing at least one --NH-- group, the acylating agent being linked to the amino compound through an imido, amido, amidine or salt linkage.

14. (Previously presented) The method of claim 1 wherein the acylated nitrogen containing compound is a polyisobutene substituted succinimide.

15. (Previously presented) The method of claim 1 wherein the lubricating oil composition further comprises a dispersant, corrosion-inhibiting agent, antioxidant, viscosity modifier, dispersant viscosity index modifier, pour point depressant, friction modifier, anti-wear agent, extreme pressure agent, fluidity modifier, copper passivator, anti-foam agent, or a mixture of two or more thereof.

16. (Previously presented) The method of claim 1 wherein the lubricating oil composition is characterized by the substantial absence of magnesium.

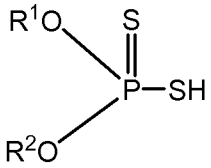
17. (Currently amended) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising: (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent, the alkali or alkaline earth metal being sodium, lithium or calcium; a zinc salt of a phosphorus-containing compound represented by the formula



(II)

wherein R^1 and R^2 independently hydrocarbyl groups, the average total number of carbon atoms per phosphorus-containing moiety being at least 10.4, wherein at least one of the ~~in~~ R^1 and R^2 groups in ~~for the~~ one or more of the phosphorus-containing compounds ~~being at least 10.4, wherein~~ contains 4 or fewer carbon atoms and up to about 40 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms; at least about 80% by weight of the phosphorus present in the lubricating oil composition being present in a compound represented by formula (II) wherein R^1 and R^2 are independently hydrocarbyl groups of about 6 to about 18 carbon atoms; and a polyisobutene substituted succinimide having a TBN of about 5 to about 30, the polyisobutene substituent having a number average molecular weight in the range of about 700 to about 3000; the lubricating oil composition being characterized by a phosphorus concentration of no more than about 0.12% by weight and the substantial absence of copper; (B) adding the lubricating oil composition to the engine; (C) operating the engine; (D) generating a lean-phosphorus containing exhaust gas; and (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.

18. (Previously presented) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising: (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent, the alkali or alkaline earth metal being sodium, lithium or calcium; a zinc salt of a phosphorus-containing compound represented by the formula



(II)

wherein R^1 and R^2 are 4-methyl-2-pentyl; and a polyisobutene substituted succinimide having a TBN of about 5 to about 30, the polyisobutene substituent having a number average molecular weight in the range of about 700 to about 3000; the lubricating oil composition being characterized by a phosphorus concentration of no more than about 0.12% by weight and the substantial absence of copper; (B) adding the lubricating oil composition to the engine; (C) operating the engine; (D) generating a lean-phosphorus containing exhaust gas; and (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.

19. (Previously presented) The method of claim 1 wherein less than 34 mole percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms.

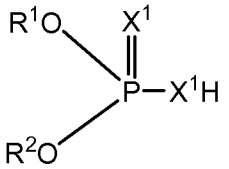
20. (Previously presented) The method of claim 1 wherein the lubricating oil composition is characterized by a phosphorus content of up to about 0.08 percent by weight phosphorus.

21. (Previously presented) The method of claim 1 wherein from about 16 to about 34 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms.

22. (Previously presented) The method of claim 1 wherein up to about 40 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms and at least 60 mole percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt are derived from secondary alcohols.

23. (Previously presented) The method of claim 1 wherein about 16 to about 34 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms and at least 60 mole percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt are derived from secondary alcohols.

24. (Currently amended) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising: (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent; a metal salt of one or more phosphorus-containing compounds represented by the formula



(I)

wherein in formula (I), X^1 and X^2 are independently O or S, and R^1 and R^2 are independently hydrocarbyl groups, the average total number of carbon atoms per phosphorus-containing moiety being at least 10.4, wherein at least one of the ~~in~~ R^1 and R^2 groups in ~~for the~~ one or more of the phosphorus-containing compounds ~~being at least 10.4,~~

~~wherein~~ contains 4 or fewer carbon atoms and up to about 40 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms, and at least 60 mole percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salts are derived from secondary alcohols; and an acylated nitrogen containing compound having at least about 10 aliphatic carbon atoms and a TBN of at least about 2; the lubricating oil composition being characterized by a phosphorus concentration of up to about 0.12% by weight and the substantial absence of copper; (B) adding the lubricating oil composition to the engine; (C) operating the engine; (D) generating a lean-phosphorus containing exhaust gas; and (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.